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NEW TECHNOLOGIES IN SLUDGE DEWATERING

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ABSTRACT

Three new dewatering methods are described in detail together with their performance capabilities. Using case histories of actual installations with these methods for the dewatering of primary and waste activated sludge mixtures operation, maintenance and design information is presented. An effort is made to critically compare these methods with those presently being used.

INTRODUCTION

An extensive review of developments in municipal wastewater treatment plant sludge dewatering technology, occuring both in the United States and abroad, was undertaken (3). The detailed technical information obtained was reviewed and compared to that currently available in design manuals and state-of-the-art documents and from equipment manufacturers. Selection for a more critical review was made of those processes which showed the greatest promise of improving sludge dewatering rate, final sludge cake solids concentration and overall sludge conditioning and dewatering system cost effectiveness.

Results indicated that Japan had and was undertaking a larger amount of developmental work than any other country. Lack of available land area for disposal and high energy costs for the sludge dewatering and incineration processes are prime motivators for their effort. Yet, the systems being developed and used there can potentially and beneficially be applied at municipalities in the United States. This paper describes in detail three new Japanese concepts and technologies which are both suitable for use in the United States and can potentially reduce sludge treatment and disposal costs. A detailed description,

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performance data, and operation and maintenance data are presented together with case studies of the new equipment's usage, where possible.

SUN SLUDGE SYSTEM

This system incorporates both conditioning and dewatering processes and is an adjunct to an existing or conventional unit (1). In the system sludge is first dewatered by conventional dewatering equipment such as vacuum filters, centrifuges, or continuous belt filters to a 20-25% solids concentration. This material is then conditioned in a unit called a disintegrating pelletizer, which first cuts the sludge cake into small particles and then coats the particles with a dry powder forming sludgelike pellets. The dry additive used should be mostly water insoluble and not break up at the high pressures used. Such materials as diatomaceous earth, gypsum, calcium carbonate, incinerator ash, coal powder, bone meal, dried pulp, sawdust and soil have been either used alone or in combination. The conditioners should usually be added in the ratio of 10-50% by weight per unit dry weight of the original sludge cake. It is important that the effective sludge particle or pellet's diameter not be greater than 20 mm (0.8 in.). Best performance occurs when the effective diameter of the pellets is between 3 and 5 mm (0.1 to 0.2 in.). Additionally, the conditioning agents must only coat the surface and not be kneaded into the sludge pellets.

The conditioned sludge cake particles are conveyed to a hydraulic press (Figure 1) where additional water is removed, and a cake of greater than 40% solids concentration is produced. The pelletized sludge is pressed between 2 sheets of filter cloth which cover thick perforated plates having perforations of 2 to 10 mm (0.1 to 0.4 in.) in diameter. Compression is carried out in two steps. The initial compression step is usually at 15 to 25 kg/cm^2 (210 - 360 psi) for 5 minutes and then the pressure is elevated to levels from 30 to 70 kg/cm^2 (430-1000 psi) for 5 minutes. In practice the compression has occurred at 15 kg/cm^2 (210 psi) for 45 secs followed by a pressure of 30 kg/cm^2 (430 psi) for 1 minute. The pelletized sludge cake is compressed by means of an oil hydraulic cylinder to form a disc-shaped solid with a 40 to 55% solids concentration. As an example, a mixture of primary and waste activated sludges having a 2% solids concentration could first be dewatered by a belt filter press to a solids contration of 25%, and then with the system just described, be further dewatered to a solids concentration of 55%.

The Ashigara Works of Japan has successfully been utilizing this process for waste activated sludge treatment since coming on stream in mid August 1982. The excess sludge is dewatered by a belt press to a water content of 80%, then pelletized and conditioned with incinerator ash and further dewatered to a water content of 50% or less. Ash is added in a ratio of 10 to 15% by weight of the amount of belt press cake. Sludge cake is incinerated and heat recovery equivalent to 30l/hour (7.9 gal/min) if fuel aid is practiced.

NEW DEWATERING MACHINE

This unit, which is shown schematically in Figure 2 has numerous circular discs on shafts similar to a rotating biological contactor. These discs constitute the filter media and rotate in a clockwise direction relative to the discharge end of the unit. Polyelectrolyte conditioned sludge is discharged onto the plates, and the sludge solids create a bridge between the discs. Filtrate passes through this bridge matrix, by capillary action and is collected in a filtrate box.

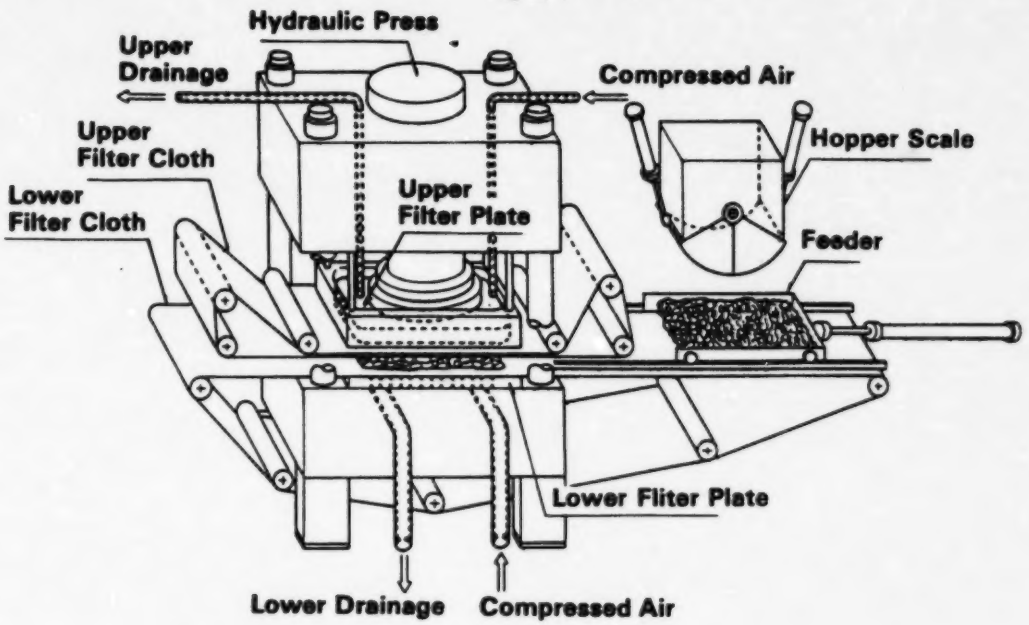


Figure 1: Structure of the "Sun Sludge Press"

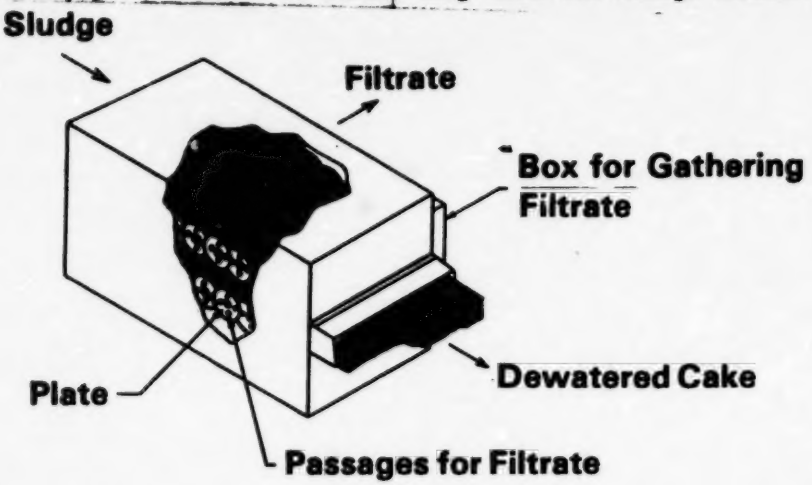
The advantages reported for this process are that a filter cloth is not needed, there is no chance of clogging the discs since they have a self-cleaning mechanism, there is less noise and vibration problems since the shafts rotate at a speed of only about 0.5 rpm and it can dewater sludges which are high in organics and/or oil.

Results of a pilot test are contained in Table 1. With a feed solids concentration of 1.9% and a 2.6 m^3/hr (92 cu. ft/hr) throughput, a cake solids concentration of 2.7% was achieved with a polymer dose of 0.4 lbs polymer/lb sludge solids.

SCREW PRESS

For many years, the screw press has been widely used for dewatering paper pulp, and for the processing of such materials as fish meal, and fruit juice and for oil expression. Since about 1979, the screw press in Japan has been used to dewater sewage sludge (2).

There are now 5 dewatering plants in Japan utilizing 8 screw presses. The screw press consists of 3 main parts; the shaft, a screen with holes that are 1 to 3 mm (0.04 to 0.12 in.) in diameter, and a drive unit. Sludge is conditioned with organic polyelectrolytes and/or if necessary, some type of a coagulant such as slaked lime and ferric chloride until a suitable floc size is attained; usually one with an effective diameter of 3 to 4.5 mm (0.12 to 0.18 in.) The conditioned sludge is fed into the hopper of the Screw Press. The first stage of the press is a gravity dewatering zone; the second stage is a pressing zone and the final stage is a squeezing zone. The screw is tapered toward the feed end, so that as the sludge proceeds through the unit, the clearance between the screen and screw decreases. Thus the equipment's design causes greater and greater pressure to be exerted upon the sludge and water is forced away from the sludge solids.



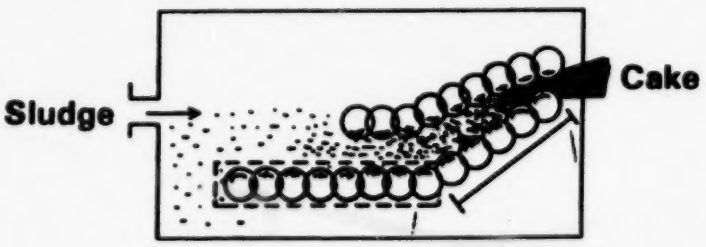


Figure 2: Two views of the "New Dewatering Machine"

Table 1

OPERATING RESULTS FOR NEW DEWATERING MACHINE WITH MIXED RAW SLUDGE

Test	Feed		Product	Chemical Dosage as %	Solids Capture
	m^3/hr	% Solids	% Solids	of Dry Solids	%
1	1.72	2.3	23.1	0.20	98.65
2	2.26	1.8	30.6	0.48	99.51
3	3.75	1.7	26.7	0.52	99.41

The resulting sludge cake is discharged onto a conveyor. Filtrate is discharged to a settling tank where any solids are removed and returned to the sludge feed stream of the Screw Press. The liquid phase is returned to the head of the plant. Typical solids capture is in the 85-98% range for a mixed of primary and waste activated sludges.

It is reported that depending on sludge characteristics and final disposal requirements, steam may be fed to the screw shaft thereby indirectly heating the sludge. This not only can increase the capacity of the unit, but also cake solids concentration possibly due to a change in viscosity. However, odor control is required when the sludge is heated. Two possible ways to accomplish this are either by combustion of the off gases in a steam boiler or by an acid scrubber.

Conditioning of the sludge is very critical for if the floc size is less than 3 mm (0.12 in.) it will pass through the screen and become part of the filtrate. In addition, a strong floc is required to withstand the pressure exerted in the squeezing zone of the press. The operator must carefully condition each sludge batch and test for floc strength and size prior to dewatering.

Information provided on this unit make it appear more economical to operate than either a belt press or centrifuge. Polymer costs are reported to be 50% less than for the other units, while power costs are 68% lower than for centrifuges, and 24% lower than for belt filter presses. The unit is reported to be easy to operate and maintain. Typical performance results from a number of sites and with different type sludges are given in Table 2.

Table 2: Performance Results of Screw Press

Sludge Type	Location	Feed Solids	Polymer %D.S.		Cake Solids	Capacity	Solid Recovery
		%	anion	cation	%	kg D.S./hr	%
Primary plus Waste-activated	Tokyo (A)	3.0	-	0.4	25-30	5 - 8	95 - 96
	" (B)	2.0	-	0.4	25-38	4 - 9	97 - 98
	Nagoya (A)	3.5	-	0.4	32-37	6 - 9	98
	" (B)	3.6	-	0.4	34-41	6 - 11	-
	Kyoto	2.5	-	0.3	31-35	5 - 9	96
	Gifu	2.4	-	0.8	33-36	6 - 9	93 - 97
	Sakai	1.4	0.2	0.8	32	9	85
Anaerobically digested primary plus waste-activated	Kyoto	2.6	-	0.3	25	3.6	-
	Kurume	2.0	0.4	1.0	26	4.2	95

Remarks: Steam pressure: 1.0 kg/cm^2
Screw rotation: 0.16 - 0.32 rpm

DISCUSSION AND CONCLUSIONS

The dewatering processes described above all appear able to achieve high cake solid concentrations with both low conditioning and power costs. The sun sludge system appears the most energy-intensive, but, it has the potential to yield the driest cake, thus significantly reducing energy costs for final disposal.

Table 3 contains typical performance data for the 3 most commonly used dewatering processes in the U. S. Comparing the results of those systems described in this paper with the commonly used units, it can be seen that, in general, the Japanese units are able to achieve drier cake solids than those considered state-of-the-art. However, care must be exercised in analyzing the performance data. For example, performance data for units which use inorganic conditioners must be corrected for the inorganics additive. Probably the best way to correlate performance from one unit to the next is on the basis of lbs. of water removed/lb of volatile solids dewatered. Therefore, automatically removing any doubt as to the actual performance of the unit.

Also, the sludges in Japan are usually different from those in the United States. They tend to be more fibrous and less volatile, and therefore may dewater more easily.

Still the performance data evaluated for the various units look very favorable and, at least on face value, meet the goals which most municipalities are looking for in dewatering equipment.

Table 3: Typical Performance Data
(50:50 Primary:WAS) 3% Solids Feed

Unit	Sludge type	% Cake Solids	Polymer Dose lb/T	Power KWH/T	% Recovery
Vac Filter	Anaer. Dig.	18-24	10-20	40-60	75-95
	Raw	16-24	10-20	40-60	75-95
Belt Press	Anaer. Dig.	20-25	6-15	10-25	95
	Raw	20-35	4-15	10-25	95
Centrifuge (Solid Bowl)	Anaer. Dig.	15-18	7-10	30-90	90-95
	Raw	18-25	3-7	30-90	90-95

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